EFFECT OF SPICES AND ESSENTIAL OILS ON GROWTH OF YEASTS

BY

ARTHUR HARPER WEBB

A. B., University of Illinois, 1939

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AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN BACTERIOLOGY IN THE GRADUATE SCHOOL OF THE UNIVERSITY OF ILLINOIS, 1944

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Spices have played an interesting role in the changing history of the world and in the lives of most individuals. It is generally recognized that their value as condiments was discovered in prehistoric times and at some likewise early period their preservative properties came to notice. The Papyrus Ebers, the earliest known medical writing, attests to use of spices among the Egyptians about 1552 B. C. and subsequent records detail information as to their use in food preservation and embalmery. In keeping with the wider application of cold as a preservative, the importance of spices as food preservatives declined almost to the vanishing point although a little interest remains mainly in the realm of home packing of foods. However as recently as 1943, Blum and Fabian advocated use of spices and their essential oils in preventing microbial scum formation on such commercial products as pickles, vinegars, and bottled wines.

Spices as preservatives, antiseptics and germicides have been investigated by many workers and from various points of view. From a historical standpoint the earliest papers in the literature deal with applications of essential oils in pharmacology and therapeutics. The next series deals with the rather large subject of food preservation, followed by the use of spices and oils as preservatives of commercial wines. From the time of Chamberland (1887), much interest has been manifested in *in vitro* experiments seeking to discover either the mechanism of inhibitory action, or resistance of various organisms under conditions modified by presence of spices or oils. These papers are followed by a trend initiated by Jensen, Wood, and Jansen (1934), in which spices themselves are shown to carry enormous loads of micro-organisms, placing somewhat in abeyance their long standing and widespread reputation for antiseptic ability.

In most experimental work testing antiseptic action of spices bacteria have been employed as experimental organisms.

The yeasts have in many instances been observed to react to stimuli in patterns comparable to those established for the bacteria but it would be incorrect to assume that under any set of experimental conditions, reactions of yeasts would be identical with those of the bacteria. Yeasts are widespread in nature and cause many troublesome fermentations in some food preserving practices, and it therefore seemed of interest to observe their growth in contact with spices and essential oils. A survey of the literature indicated a great deal of confusion as to which spices and oils were effective inhibitors of bacterial growth and as to whether those spices conceded to be inhibitory were bacteriostatic or bactericidal in effect.

This investigation was designed with the purpose of gaining information which might prove useful in contributing to answers to the above problems. Spices and oils were obtained from commercial vendors and yeasts were from the collection maintained by the Department of Bacteriology, University of Illinois. In one experiment ground spices in varying percentages by weight were added to dextrose broth fermentation tubes, innoculated with yeasts and reactions in terms of fermentability recorded. Ground cinnamon, cloves, and allspice prevented growth of yeasts in 1-50 concentration. Ground cinnamon was able to completely inhibit one species of yeast in a concentration of 1-1000.

The same yeasts including *Zygosaccharomyces priorianus, Oidium lactis, Torula sphaerica, Saccharomyces cerevisiae,* and *Mycoderma vinii* were grown on Frost double plates containing on one side dextrose agar, and on the other dextrose agar plus various concentrations of ground spices. Concentrations of one-tenth per cent markedly inhibited but did not prevent growth of yeasts. Ability of the yeasts to adapt themselves to the disinfectant action of the spices was demonstrated by development of spearheads of resistant growth on agar saturated with active disinfectant principle emanating from the spices. Nutmeg, bay leaves, paprika, ginger and peppers were unable to prevent growth of yeasts in concentrations of ten per cent.

With spice oils in Frost double plates yeasts were unable to grow in presence of oils of mustard, cinnamon, and cloves in one per cent concentrations. Oils of anise, wintergreen and onion

were germicidal above five per cent, and oils of black and white peppers appeared to contain materials which stimulated growth of yeasts. Results of experiments using the Reddish Cup-plate technique indicated that inhibiting or disinfectant principle is concentrated many more fold in essential oils than in ground spices. Oils of almond and bay along with mustard, cinnamon, and cloves, were uniformly lethal to yeast cells. Undiluted oils of anise, nutmeg, peppermint, wintergreen, lemon, and onion were in several instances germicidal, and were without exception bacteriostatic. The oils of ginger and vanilla were negative in effect, and vigor of test yeasts seemed to increase in direct proportion to concentration of oils of black and white peppers in the medium.

As a result of this study it can be concluded that ground cinnamon, and cloves are effective and perhaps practical inhibitors of yeast growth, that essential oils of mustard, cinnamon, and cloves, are lethal in strong degree to yeast cells, and that oils of allspice, almond, anise, and wintergreen are effective inhibitors of yeasts. Not only are the peppers not inhibitory for the yeasts, but appear to be able to stimulate them.

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